Psychophysiological Profiles of Sleep Deprivation and Stress during Marine Corps Training

Chris Berka[1], Gene Davis[1], Robin Johnson[1], Daniel J. Levendowski[1], Melissa Whitmoyer[1], Robin Fatch[1], Wayne Ensign[2], Matthew A. Yanagi[2], and Richard Olmstead[3]

(1) Advanced Brain Monitoring, Inc., Carlsbad, CA,

(2) SPAWAR, San Diego, CA,

(3) VA Greater Los Angeles Healthcare System

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Introduction: Study Goals & Rationale

- Assess fatigue and stress and their effects on situation awareness and decision-making during 28-day USMC Mojave Viper training
- Evaluate utility of EEG, EKG, actigraphy in predicting performance deficits in an operational setting

Value to USMC

Better awareness of team capabilities

Improve safety and mission management

Fatigue management

Challenges of the operational environment

Mojave Viper training at 29 Palms

- 28-day training event covering all USMC operations in desert & urban environments
- Final training prior to deployment in Iraq or Afghanistan

Main objectives

1. Demonstrate that marines experience fatigue during training using objective measures.

2. Assess effects of fatigue and/or stress on performance during training.

Methods: participants & meaures

- N=17 platoon, squad & fire team leaders
- Continuous actigraphy throughout testing
- Baseline and repeated sessions (1/wk)
  - 30-minute EEG, EKG, 3-Choice Vigilance
  - Saliva cortisol levels
  - Subjective measures
    - POMS
    - Brief Fatigue Inventory
    - Perceived Stress Scale
    - Subjective Sleepiness Scale

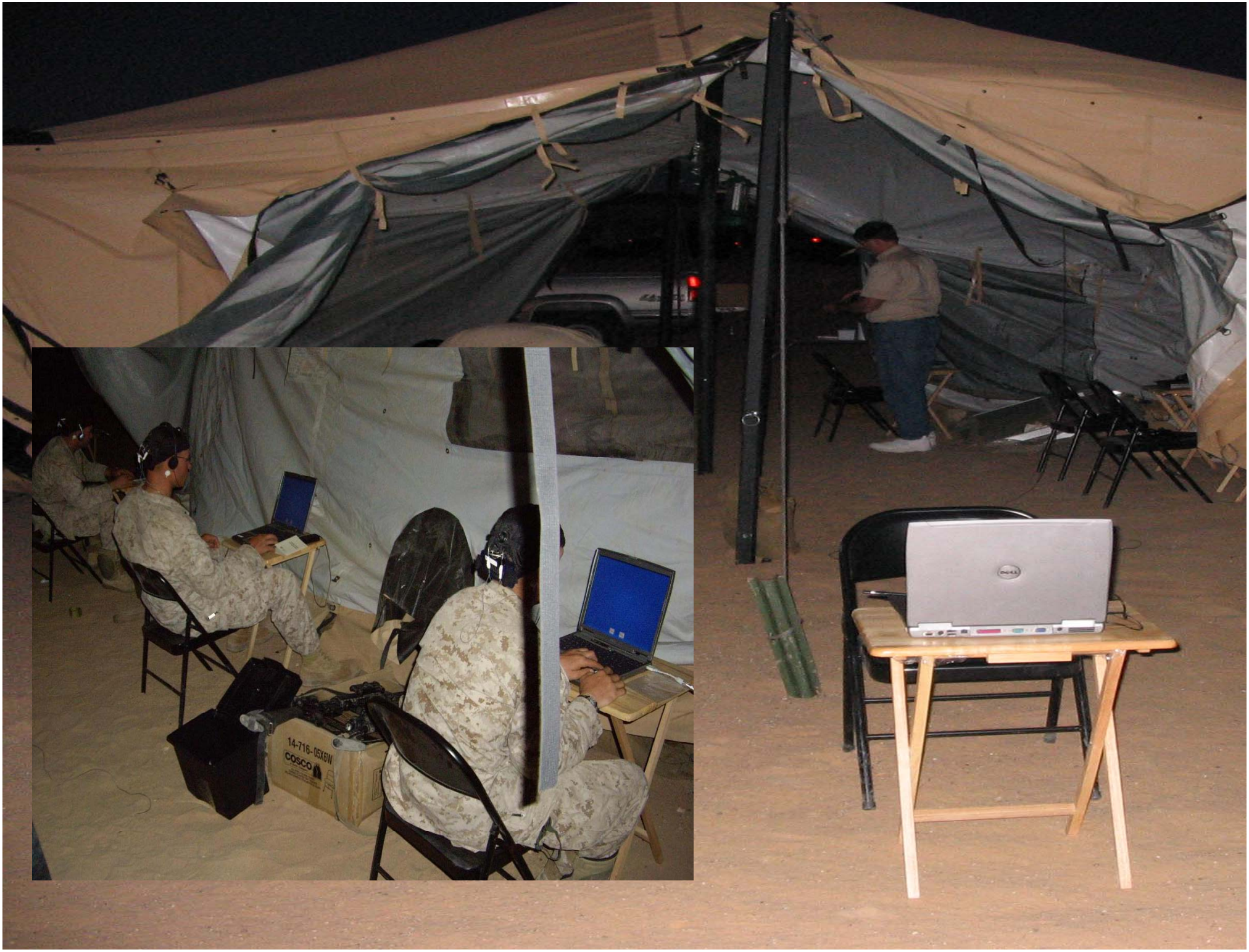
Mobile Wireless EEG System

No-prep sensors

Battery-powered

Automate artifact detect / decon

- EEG sensors at Fz, Cz, POz referenced to linked mastoids, bipolar Fz-PO and Cz-PO
- EKG sensors on collarbone & lower rib
- System proved durable in field environment
  - ✓ Marines quickly learned to self-apply
  - ✓ No issues with comfort or usability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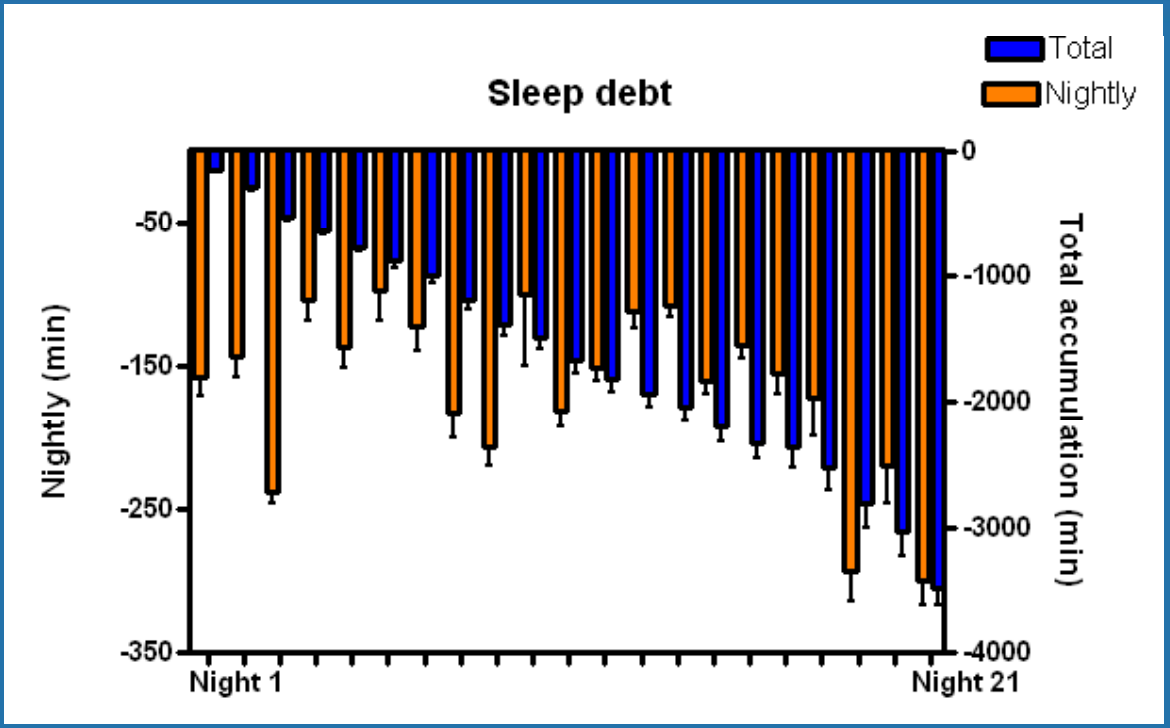
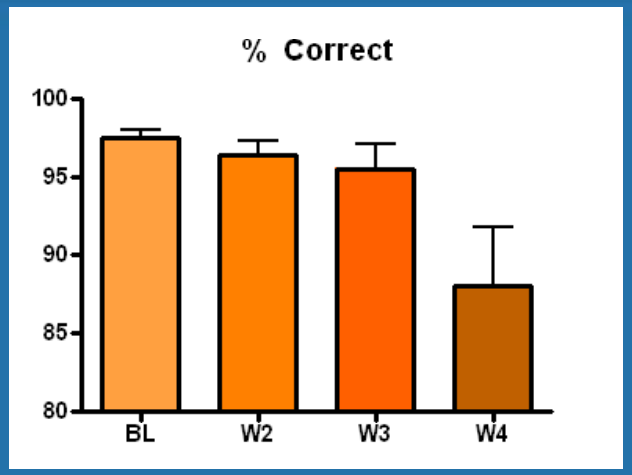
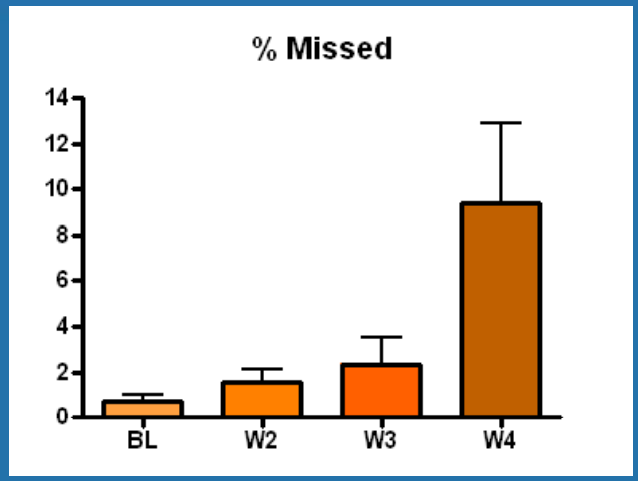
Results: Actigraphy- Sleep Debt

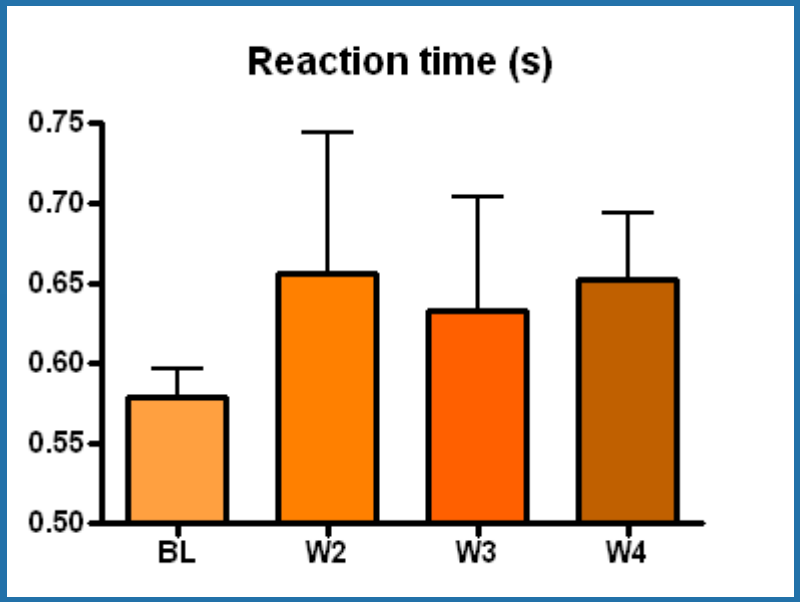


- Sleep debt calculated by subtracting recommended sleep period (8 h/ 480 min) from actual sleep minutes.
- By night 21, the marines average 58 hours of accumulated sleep debt

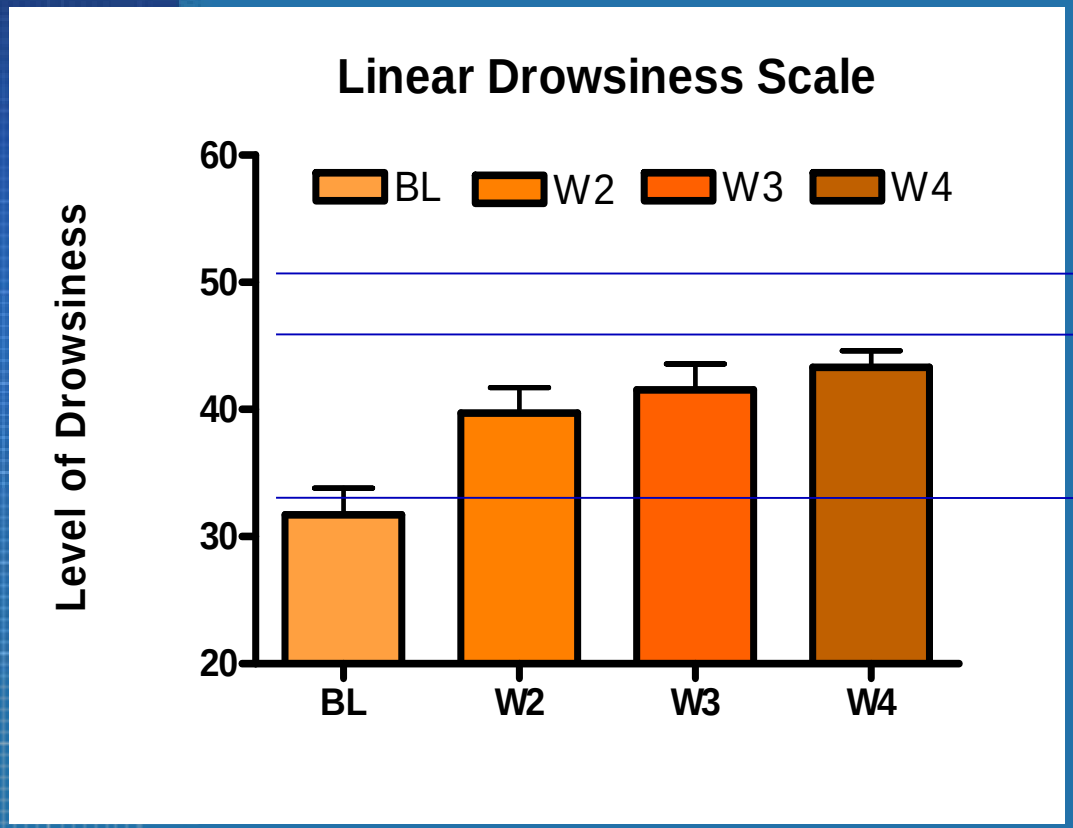
Results: 3-Choice Vigilance Test

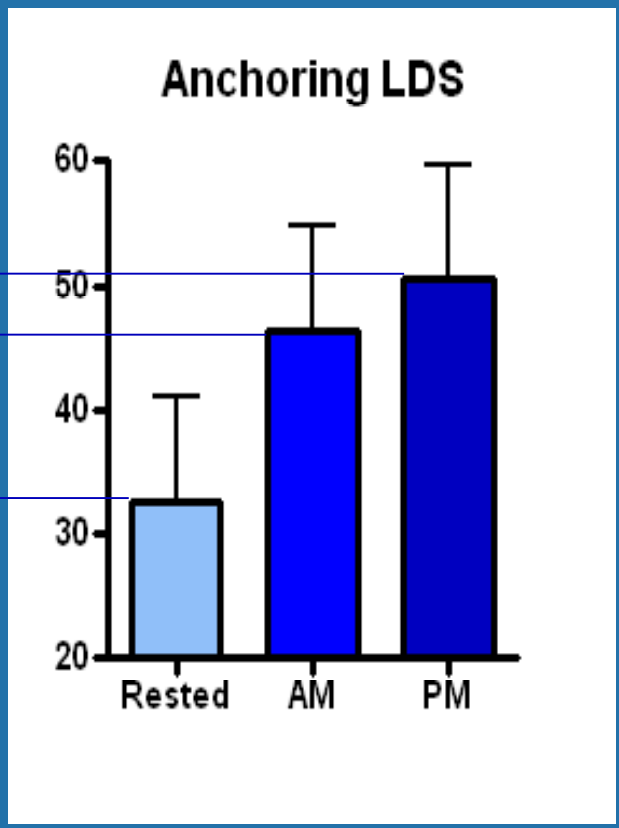




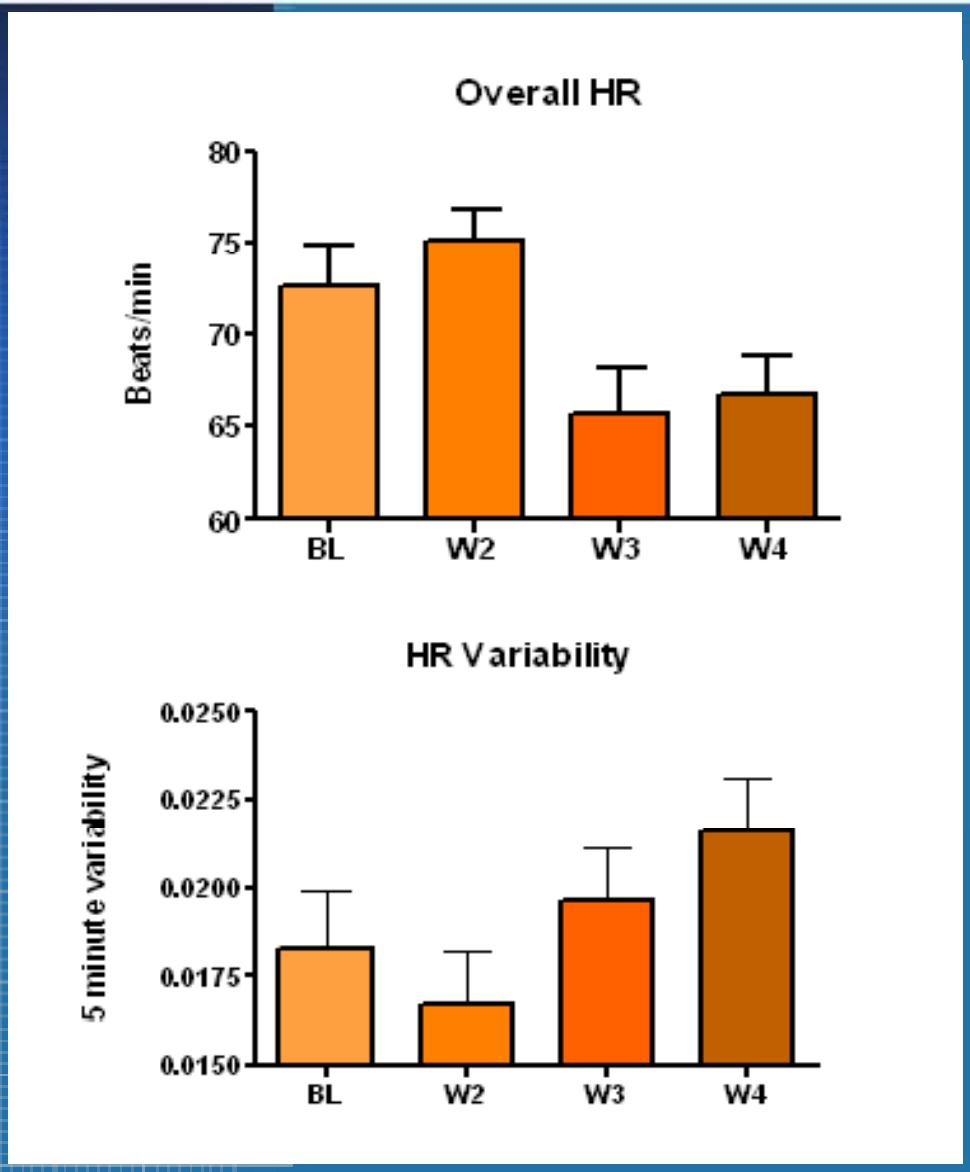


Results: EEG-based Fatigue indications





Results: Heart rate/variability



HR/HRV measures

Calculated on 5 min. windows during testing

HRV: coefficient of variation based on median

Mean HR significantly decreased at weeks 3 & 4

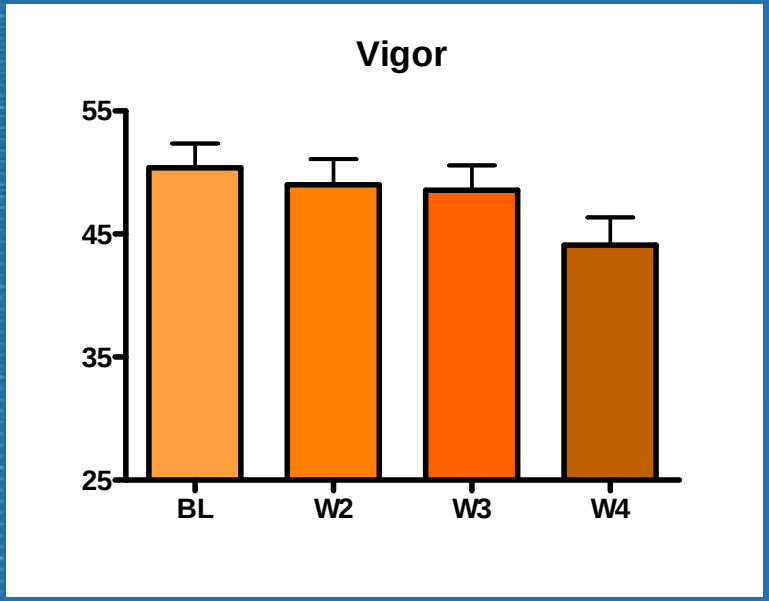
Mean HRV significantly increased at week 4

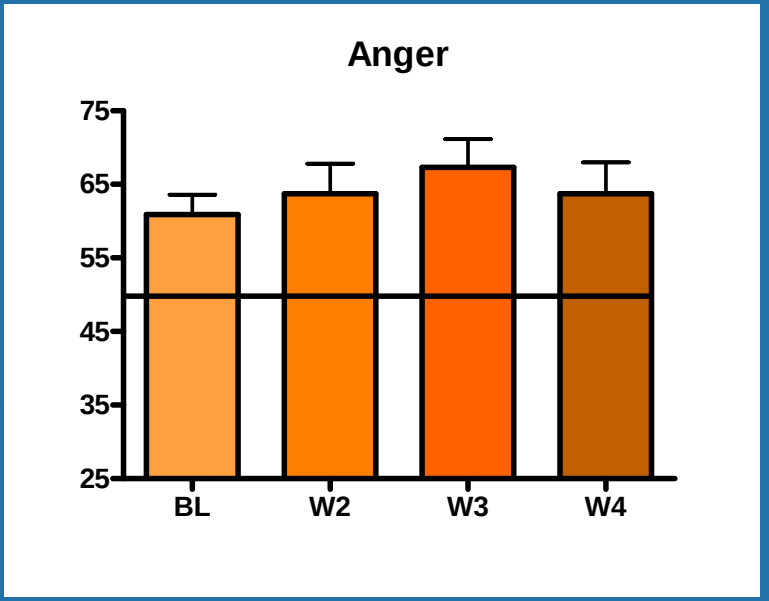
Results: Subjective Measures

POMs Vigor significantly decreased at week 4.

Marine anger levels were above normal on POMs.

No changes observed in other subjective measures

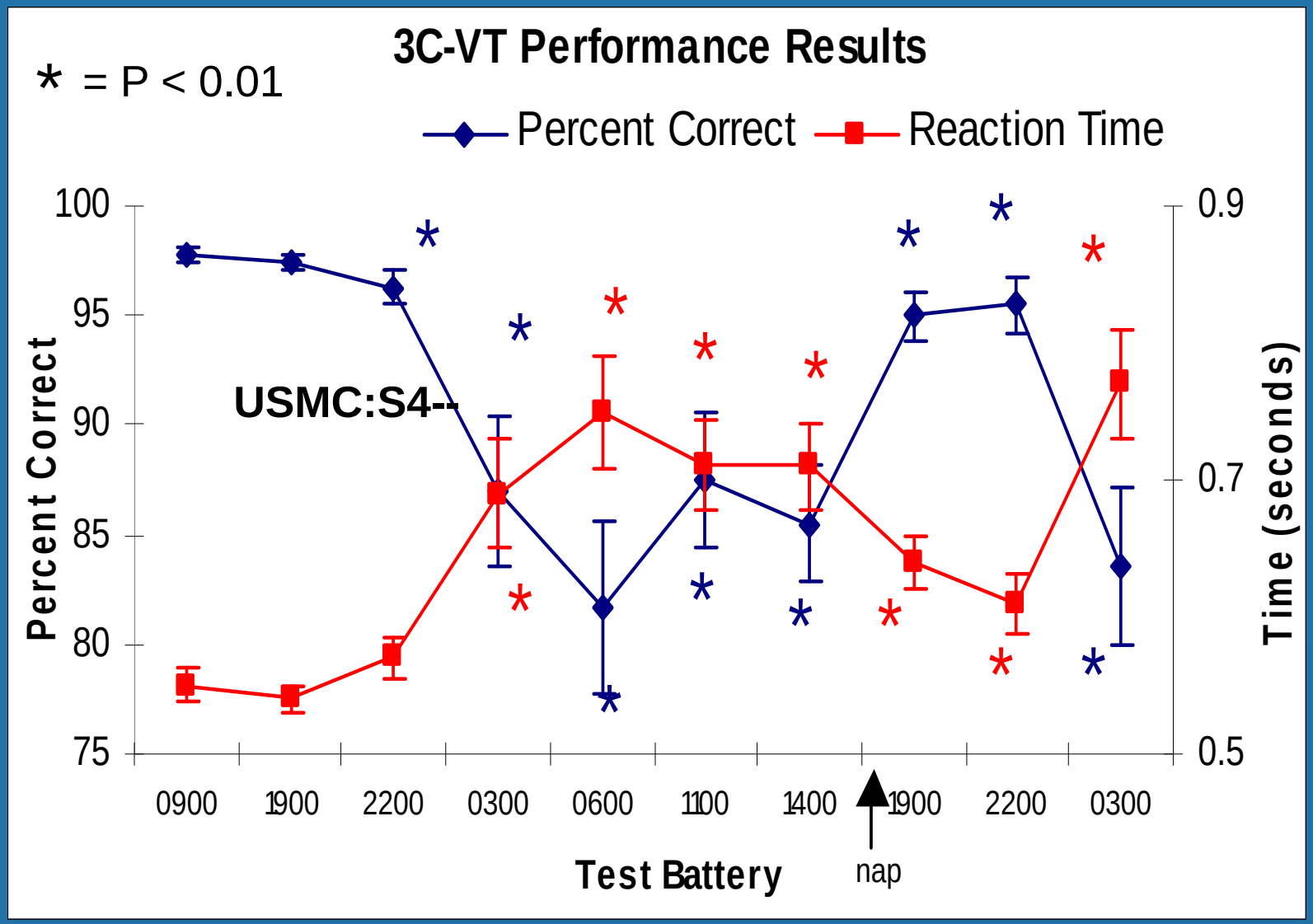




Addressing the Baseline Problem

- Scheduling morning sessions for baselines is impossible with USMC at 29 Palms
- Approvals from command were obtained just prior to start of Mojave Viper
- A fully-rested, stress-free baseline may be impossible to obtain from active marines
- Potential solutions
  - Compare to ABM healthy database (n=200) fully-rested & sleep-deprived
  - Acquire data from fully-rested marines when they first arrive at Camp Pendleton

Results: 3C-VT Accuracy & Reaction Time



Conclusions

- Mobile wireless EEG/HR/HRV acquisition technologies provide valid objective measures of fatigue in an operation environment
- Data obtained without interfering in ongoing operations
- EEG/HR/HRV assessed during the 3C-VT quantitatively showed fatigue to be a serious problem in Marines before deployment
- Data indicate that Marines do not self-report fatigue, increasing the need for objective measurements of fatigue

Relevance of Study Results

- Fatigue in USMC convoy operations is a serious problem
- Estimated 35-50% of US casualties in Iraq occur during convoy attack
- Results suggest feasibility of objective fatigue assessment in operational settings
- Coupled with appropriate interventions fatigue monitoring could improve safety and save lives

Advanced Brain Monitoring, Inc.

Q & A